Abstract No. Gaut0433

Monomer Conversion of Dental Resins

M.A. Gauthier, T.H. Ellis, X.X. Zhu (U. of Montreal), I. Stangel (BioMat Sciences)

Beamline(s): U10B

Introduction: The potential toxicity of methacrylate monomers in dental resins points to the development of new polymerization techniques yielding increased conversion ratios and reduced monomer “leaching”. Oxygen inhibition of free-radical polymerizations yield uncured surface layers on visible-light cured samples. While the dentist can mechanically remove these uncured layers, the reduction of monomer conversion in this region poses serious health risks. The purpose of this study was to compare the degree of conversion (DC) for two methods of resin polymerization, the hypothesis being that microwave irradiation increases the DC compared to current photo-initiated reactions.

Methods and Materials: Samples were cut perpendicular to the surface and the DC was measured along the cut by Raman and FTIR microscopy (specular reflectance). Synchrotron FTIR microscopy was also performed in transmission geometry on 10um thick samples. Uncut samples were investigated by depth profiling techniques such as confocal Raman “Z-profiling” and photoacoustic FTIR depth profiling.

Results: Microwave irradiated samples showed no evolution of DC from the surface to a depth of 800 um. Photo-initiated samples show an evolution of the DC from the inhibited surface (10% conversion) to the uninhibited bulk (80% conversion) over a distance of 35um. Results were consistent between the different Raman sampling techniques. Specular reflection FTIR microscopy overestimated the degree of cure in the inhibited region; this is due to the poor spatial resolution of this sampling technique. Transmission FTIR microscopy showed results consistent with Raman data after the first 20um; the microtoming of these samples being responsible for the removal of the top layer (~20um) of these samples. Photoacoustic depth profiling yielded good agreement for surface and bulk values; however the evolution between the two was pushed towards shallower depths. This is due to the response profile of the photoacoustic method as a function of depth (the way in which the spectrometer actually “sees” the sample).

Conclusions: We conclude that microwave irradiation of the resins is effective for enhancing the degree of conversion, but only at the surface where a high oxygen concentration is present. These results seem promising for the development of compact microwave sources for clinical applications. This work will also permit a better comprehension of the complicated photoacoustic depth profiles of “gradient” samples. Through our work with rectangular apertures, sub-diffraction limited spatial resolution was attainable by synchrotron FTIR microscopy. Raman microspectroscopy allowed for the highest spatial resolution of all our sampling techniques. This is due to the highly collimated and focused visible light laser excitation source used in this method.

Acknowledgments: N. Marinkovic (U10B at the NSLS), Natural Sciences and Engineering Council of Canada (NSERC), Fonds de Recherche sur la Nature et les Technologies (FCAR)